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A feasibility study on the implementation of teleophthalmology in the Medical Treatment Facilities in the Great Plains Regional Medical Command

A Graduate Management Project Submitted to:

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ABSTRACT

With the ever increasing costs of health care today finding, testing, and, if found workable, utilizing a new technology is an absolute must. Teleophthalmology is just such a technology. This service will greatly benefit the present and growing diabetic population. One of the major complications of diabetes is diabetic retinopathy, which eventually causes blindness. The effects of diabetic retinopathy can be limited if early and effective treatment is provided. The key to early intervention is an annual eye exam. The compliance rate for annual eye exams for Great Plains Regional Medical Command is less than the 90% required to meet HEDIS as well as our own Clinical Practice Guideline metric. Teleophthalmology is a way to meet the needs of the patient for an eye exam without a second visit to the hospital. Utilizing a digital ophthalmic camera allows the patient's pupils to be dilated, the films obtained and sent for review by an ophthalmologist during their routine primary care visit. This decreases the hassle factor for the patient, it frees up ophthalmology clinic visits held for routine diabetic eye exams, and best utilizes the limited number of ophthalmology providers available in the region.

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INTRODUCTION

Great Plains Regional Medical Command (GPRMC) serves as the command and control headquarters for the delivery of health care in a geographical area that covers 16 states and includes ten Military Treatment Facilities (MTF). The mission of GPRMC is to "have regional command and control of a cost effective, multidisciplinary, customer focused, quality integrated health service system." (Great Plains Regional Medical Command, 2003 web home page)

In order to provide quality as well as cost-effective medical care, an organization must learn to utilize all appropriate technologies. The newest technology available to a health care organization is telemedicine. Telemedicine is an all-encompassing term regarding any medical treatment done over a distance. Shi and Singh (2001) define telemedicine as the "use of telecommunications technology that enables physicians to conduct two-way interactive video consultations or to transmit digital images such as X-rays and MRIs to other sites." (p. 598)

Teleophthalmology is a type of telemedicine, involving the use of digital photography to obtain printable or displayable views of the eyes for evaluation. This becomes an important and useful tool when providing care for patients with diabetes mellitus (DM). A major complication of DM is diabetic retinopathy (DR), a condition resulting in decreased visual acuity or visual impairment. Diabetic retinopathy is the leading cause of new cases of blindness in the 25 to 64 age groups, and can be diagnosed by a simple dilated eye exam performed by an ophthalmologist or retinal specialist. Early detection and treatment of DR is a cost-effective medical intervention. (ADA) By ensuring a diabetic obtains an annual eye exam, diagnosis and treatment can be provided. Once diagnosed, various treatments are available to the patient to preserve their present level of vision. Teleophthalmology allows for this exam to be done without the patient making a second appointment. Digital photographs can be obtained and electronically sent to the ophthalmologist for review. This decreases the hassle factor to patients and decreases the cost of providing and purchasing the service.

Direct medical costs for DM per the American Diabetic Association (ADA Diabetes and indirect costs of diabetes in the United States, retrieved September 22, 2003) were an estimated $91.8 billion in 2002, representing 19% of personal health care dollars spent. Of the $91.8 billion, $40.3 billion was for inpatient care and $13.8 billion was for nursing home care. Indirect care costs resulted from lost workdays, restricted activities, mortality, and permanent disability with an economic price of $39.8 billion. People suffering a permanent disability as a result of DM in 2002 were estimated at 176,000.

Teleophthalmology is not the first endeavor to utilize digital technology in GPRMC. It is a natural extension of programs already in place. The region developed and initiated venture capital programs involving teleradiology, teledermatology, and tele-echocardiology, all of which use digital imaging. Teleradiology was proposed in 1996 with initial use and tracking started in January 2002. Office of the Surgeon General (OTSG) venture capital approval was received in March 2003. Teledermatology began in 2002 at Fort Hood and received venture capital monies approval in FY04. Tele-echocardiology began January 2002 at Forts Hood, Sill, Polk, Carson, and Leonard Wood. It was approved for venture capital financing in FY04. To date all three systems, according to Mr. Gary Crouch, Director of telemedicine at GPRMC, have been cost-effective and teleophthalmology should be no different.

CONDITIONS THAT PROMPTED THE STUDY

In GPRMC there is an estimated 9,000 diabetic patients (See Appendix A). Nearly all patients with diabetes develop some form of retinopathy. The incidence rate of diabetic retinopathy depends on the type of diabetes, the control level of the individual's blood sugar, and the age of onset of the disease. The World Health Organization (WHO) estimates that those with diabetes for over 15 years, approximately 2% will become blind, and 10% will develop a severe visual handicap. (American Telemedicine Association, 2004) The Population Health Operational Tracking and Optimization database shows GPRMC having only 30% of our diabetic patients receiving an annual eye exam.

With the guidelines for yearly screening well documented and accepted by the medical community the compliance rate for this metric at Brooke Army Medical Center (BAMC) is presently 61%. Colonel Wendall Bauman, United States Air Force, an ophthalmologist in the Eye Clinic at BAMC conducted an, at present, unpublished study from April 2002 through May 2003 looking at increasing the compliance rate (Bauman, 2003). He found he could raise the compliancy rate to 80% by hiring a diabetic screening photographer to augment the present staff of one retina specialist, one resource share photographer/coordinator, and utilizing digital retinal imaging.

A typical diabetic patient is seen by his or her Primary Care Manager for routine checks for blood sugar control, lipids, and blood pressure. The patient is then sent to various other clinics or offices to obtain all other consultations. These appointments are often scheduled for different days or times than their original primary appointment. This inconvenience to the patient results in additional missed work, use of sick time, and often missed appointments. In many cases the patient is unable to schedule the appointment due to personal or work conflicts. The patient then has to decide what opportunity they are going to pass up. Too often it is the routine eye exam that is missed. As stated previously, for a diabetic this could have serious repercussions and ultimately cost the patient and the facility more to provide appropriate medical care.

The question then becomes one of determining a better method of assisting diabetic patients to receive the needed yearly eye exam. There have been many advances in the field of medicine in regards to how care can be provided. One of these advances is the use of telemedicine, which combines medical knowledge with electronic capabilities. The use and accuracy of digital retinal photography is now well documented and accepted. It also provides a means to perform a thorough eye exam for diabetic patients without requiring a special visit to the ophthalmologist. Utilizing this new technology has the potential to increase our compliance rate for annual diabetic eye exams as recommended by clinical performance guidelines, save dollars and manhours.

STATEMENT OF THE PROBLEM

The MTFs in the Great Plains Regional Medical Command need to determine the potential for and the cost-effectiveness of implementing teleophthalmology.

LITERATURE REVIEW

Diabetic Retinopathy

Diabetes Mellitus (DM) is a chronic disease affecting the endocrine system and affects a persons' ability to properly use insulin. According to the ADA this disease affects approximately seventeen million people in the United States. Of these seventeen million there are eleven million diagnosed cases and unfortunately 5.9 million people who have the disease but not officially diagnosed. This represents 6.2% of the American population. The annual per capita economic cost for providing health care to this population has risen from $10,071 in 1997 to $13,243 in 2002, which is a 30% increase. (American Diabetes Association, 2003)

Diabetes exists in two forms and they are classified as Types 2 and 1. Type 1 refers to those having Insulin Dependent Diabetes Mellitus (IDDM). Type 2 diabetics are those with Non-insulin Dependent Diabetes Mellitus (NIDDM). Type 1 diabetes results from the pancreas not producing insulin and affects approximately 5-10% of those diagnosed with DM. Type 2 diabetes results from the body’s inability to properly utilize insulin or supply an insufficient amount. This type affects approximately 90 –95% of those diagnosed with Diabetes Mellitus.

Diabetic Retinopathy is a major complication of DM. Eventually nearly 100% of all patients with DM develops some degree of retinopathy. As noted earlier, this is the leading cause of new cases of blindness in the 25 to 64 age groups. Both Types 2 and 1 carry a high risk factor for developing a complication of visual impairment. Of these two, Type 1 carries the higher risk.

Diabetic retinopathy is a general term for all disorders of the small blood vessels of the retina caused by diabetes.

(American Diabetes Association, 2003) These include problems with weakening of the blood vessel walls or leakage from these same blood vessels. The presence of retinopathy in Type 1 DM is seen in those who have had the disease for 20 years. Of those diagnosed with Type 2, 21% have some degree of retinopathy when first diagnosed with DM and most will eventually develop some amount of retinopathy. The ADA states that eight percent of legal blindness is directly related to Diabetes Mellitus.

Diabetic retinopathy exists in two major forms nonproliferative and proliferative retinopathy and is progressive in nature. Nonproliferative retinopathy is common, usually mild, and generally does not affect a person’s vision. Visual impairment occurs when the retinopathy involves the macula of the retina. The macula is the source of our sharpest vision. If the retinopathy is not treated it can progress to the more harmful form, proliferative. Proliferative retinopathy forms when new blood vessels form around the retina. Loss of vision can occur due to these vessels bleeding into the inner eye or the swelling of the retina. Nonproliferative retinopathy is generally asymptomatic. Proliferative forms are also until it is often too late and major damage to the retinal has occurred.

Several risk factors have been identified to determine an individual's likeliness to develop retinopathy. These factors are blood sugar control, number of years having DM, control of the blood pressure and an individual's genetic makeup. Studies have shown that the control of the blood glucose levels is of paramount importance. Patients with levels close to the accepted normal level have fewer or milder complications. Due to the nature of diabetic retinopathy, a yearly eye exam is strongly encouraged in order to monitor the status of the eye and perform interventions as needed. Interventions or treatments include scatter photocoagulation, focal photocoagulation, and vitrectomy. Photocoagulation uses small laser burns on the retina to stop the blood vessels from growing or leaking. Scatter photocoagulation burns are made in a polka dot pattern and can be done on more than one occasion. This treatment is most effective when bleeding or detachment is in its earliest stages. Focal photocoagulation also uses laser burns but the burn is to specific leaking vessels. Damage that has occurred is not reversible. Vitrectomy is the surgical removal of the scar tissue and cloudy fluid that has collected inside the eye. Again, the earlier the intervention, the better the results.

Many studies, to include The Diabetes Control and Complications Trial, have demonstrated as well as documented the need for good eye care. The American Diabetes Association (ADA) Position Paper on Diabetic Retinopathy states, as per the Wisconsin Epidemiologic Study of Diabetic Retinopathy (WESDR), that diabetes poses a severe threat to vision. (American Diabetes Association, 1998, p. 157) The ADA position paper also noted that the prevalence of eye complications is directly related to the duration of the disease. "3.6% of younger-onset patients (aged <30 years at diagnosis, an operational definition of Type 1 diabetes) and 1.6% of older-onset patients (aged ≥ 30 years at diagnosis, an operational definition of Type 2 diabetes) were legally blind." (American Diabetes Association, 1998, p. 157) Medicine does not, at present, have a cure or a method of prevention for Diabetes Mellitus. What medicine can do is to moderate the complications rising from this disease. As has been stated blindness is a primary complication. The American Academy of Ophthalmology recommends that all diabetics have an annual eye exam performed by an ophthalmologist trained in screening for diabetic retinopathy. See Table 1 for detailed recommendations.

Table 1

Eye Examination Schedule

Age of Onset of Diabetes Mellitus	Recommended Time of First Exam	Routine Minimum Follow-up*
0 -30	5 years after onset	Yearly
31 and older	At time of diagnosis	Yearly
Prior to pregnancy	Prior to conception or early first trimester	3 months

Source: American College of Physicians, American Diabetes Association, American Academy of Ophthalmology: Screening guidelines for diabetic retinopathy, Clinical Guideline. Ophthalmology 1992; 99: 1626-1628 (TAAO.1993)

*Abnormal findings will dictate more frequent follow-up examinations.

The main reason for screening for diabetic retinopathy is that early diagnosis with effective treatment results in limited damage to the individuals' vision. The treatment for retinopathy is laser photocoagulation. The Diabetes Control and Complications Trial and the Early Treatment Diabetic Retinopathy Study (ETDRS) both provide strong support for the efficacy of photocoagulation surgery. (American Diabetes Association, 1998, p. 157) While laser photocoagulation surgery showed it could stem vision loss it could not alter what had already occurred. This result emphasizes the need for annual screening for early detection of visual complications.

Screening is necessary as most patients are asymptomatic and they do not realize there is a problem until it is too late. Screening has proven itself to be cost-effective. The cost of screening can and usually is “less than the disability payments provided to people who would go blind in the absence of a screening program.” American Diabetes Association (1998, p. 158) The cost-effectiveness of screening has been replicated in studies performed in Australia, the United Kingdom, and the Scandinavian countries. (Javitt, 2000) Javitt goes on to write, “The important point is that any delay beyond the 2-year mark rapidly increases the number of cases of needless blindness.” (Javitt, 2000, p. 437)

In conjunction with the guidelines for screening stated earlier, the National Committee for Quality Assurance (NCQA) in their Health Plan Employer Data and Information Set (HEDIS) for Medicare 2002 incorporated the yearly eye exam in their requirements for meeting the standard for Comprehensive Diabetes Care. (National Committee for Quality Assurance, 2003)

Diabetic retinopathy afflicts a large portion of those with diabetes be it type 1 or type 2. Screening for visual impairment or retinopathy is therefore a “valued and required strategy” (American Diabetes Association, 1998, p. 158) The Diabetes Control and Complications Trial (DCCT) is a landmark study looking at the relationship between control of blood glucose levels and incidence of complications directly related to diabetes. The ADA accepts this study has having “both statistical and clinical significance.” (American Diabetes Association, 2003, p. 1) In an article written by the Massachusetts Medical Society the DCCT’s principle outcome was “the likelihood (odds) of an increase in retinopathy of three or more steps from baseline was 76 percent lower in the intensive-therapy group than in the conventional group.” (Massachusetts Medical Society, 2000, p. 384)

The Diabetic Retinopathy Vitrectomy Study (DRVS) focused on comparing early vitrectomy and conventional management, for recent severe vitreous hemorrhage secondary to very severe proliferative diabetic retinopathy. Vitrectomy is a procedure involving the removal of vitreous hemorrhage in the eye and relief of traction on the retina occurring due to the presence of DR. The DRVS conclusion “supports early vitrectomy in eyes known or suspected to have very severe proliferative diabetic retinopathy as a means of increasing the chance of restoring or maintaining good vision.” (Clinical Studies 99, p. 2, 3)

Telemedicine

Telemedicine is an all-encompassing term regarding any medical treatment done over a distance. The term relates back to the practice of ship to shore radio for providing medical advice to a ship's captain. (Wootton, 2001) According to Wootton, telemedicine's implementation is slow due to the lack of scientific studies demonstrating its ability to be cost effective. Along with being cost-effective, the technology must prove to be superior to the method it intends to replace or its ability to provide equally effective care as that which it seeks to augment.

The assessment process for implementation "should provide a broad description of telemedicine that covers, technical, clinical, economic, ethical, legal, and organizational issues." (Roine, Ohinmaa, & Hailey, 2001, p. 765) Other issues delaying wider implementation of telemedicine are bandwidth requirements, medico-legal issues, and state licensure. Bandwidth is becoming less of an issue with our increasing technology but the medico-legal and licensure issues are still relative unknowns.

Telemedicine as a consultative tool is well accepted by both physicians and patients. (Frey & Bratton, 2002) Patient satisfaction, a major factor in medical decision making for implementing new programs, has shown a marked acceptance of this new technology and method of administering health care. (Mair & Whitten, 2000) Physician acceptance has been slower due to legal and reimbursement issues. As Frey and Bratton noted, the ultimate success of telemedicine is dependent upon third party reimbursement.

Telemedicine is a subset of telehealth, which includes many different medical specialties. (Walker, 1997) Telemedicine has several issues that must be addressed prior to its total acceptance. These issues include: standard of care for medical encounters and defining what is the patient-provider relationship. To date these issues have not been addressed by the court system. Frey states in his article that The American Medical Association (AMA) is "skeptical that any computer-based examination, even with the assistance of audio and video real-time equipment interactions, is suitable for making medical decisions." (Frey & Bratton, 2002, p. 171) There are other legal issues to be looked at such as malpractice liability for an inaccurate telemedicine opinion as well as who is responsible for the reliability of the technology itself. (Hodge, Gostin, & Jacobson, 1999) Even with these existing limitations telemedicine is being incorporated into main stream medical care.

The Veterans Health Administration considers telemedicine to be an enabling technology. Providers using this technology are credentialed in the same manner as any other provider. (Garthwaite, 1999) The importance of protecting personally identifiable information when using telehealth technology is well known and was addressed in the Health Insurance Portability and Accountability Act of 1999.

Cost Accounting

Health care expenditures in the United States account for approximately 14% of the gross domestic product. The ADA position paper on diabetic retinopathy found that the cost for screening for retinopathy is normally less than disability payments to those who would go blind in the absence of a screening program. (American Diabetes Association, 1998) Determining a more economic means of providing diabetic eye care is a must. There are four major types of economic evaluation: 1) cost analyses, 2) cost-utility analysis, 3) cost-benefit analysis, and 4) cost-effective analysis. (Lee & Zhang, 2003) Cost analyses consist of cost-minimization or cost-consequences analyses. Cost-consequences looks at the costs of a program while cost-minimization compares the cost of programs achieving the same effectiveness. Cost-utility analysis focuses on the benefit as measured by the number of life years saved while adjusting the cost to reflect changes in life style due to morbidity or side effects of an intervention. Cost-benefit analysis measures the effectiveness of a treatment in terms of the dollars saved or added. Cost-effectiveness analysis looks at life years saved, disability days, or adverse events/infections avoided for a given treatment or process.

According to Lee & Zhang, economic analysis must address five areas: 1) obtaining a clear understanding of the study perspective to determine results, including the societal perspective as a frame of reference; 2) identifying how economists measure costs; 3) determining what economic pieces belong in the study; 4) identifying where data was obtained and any assumptions made; and 5) determining how benefit is measured.

In a metanalysis study of telemedicine cost-effectiveness studies Whitten et al (2002) found "most of the studies entirely equated benefits with cost savings, with no analysis of changes in benefit to patients." (p. 136) Since early cost evaluations may not reflect changes to costs and benefits arising from the introduction of the new practice, sensitivity analysis becomes essential. (Scuffham, 2002) Whitten et al found that "comparative cost effectiveness of telemedicine systems depends on the unique location aspects of the individual service being evaluated."(Whitten et al. 2002, p. 1437)

Cost-effective analysis (CEA) is a basic tool to evaluate health care practices. To develop a consensus the US Public Health Service convened The Panel on Cost-effectiveness in Health and Medicine. The panels' participants were nonfederal professionals with expertise in CEA, clinical medicine, ethics, and health outcomes measurement. (Russell, Gold, Siegel, Daniels, & Weinstein, 1996, p. 1172) The panel developed a set of recommendations to standardize the process for performing a CEA. The panel's recommendations fall into eight categories: 1) nature and limits of CEA, 2) components in the numerator and denominator, 3) measuring numerator in terms of costs, 4) valuing the health in the denominator, 5) estimating effectiveness of interventions, 6) time preference and discounting, 7) handling uncertainty, and 8) reporting guidelines. The panel recommended including a reference case in every CEA to allow for comparisons across interventions. (Weinstein, Siegel, Gold, Kamlet, & Russell, 1996, p. 1253)

A CEA must include all societal perspectives and all important impacts on health and resources. These perspectives are reflected in either the numerator or denominator. The convention is for the denominator of a C/E ratio to be reserved for the improvement in health associated with an intervention. (Weinstein et al 1996) The numerator reflects changes in resources associated with an intervention. Costs should be measured in constant dollars, or dollars spent in a fixed year. Labor costs are reflected in the wage rate. QALYs reflect nonhealth care costs. A set discount rate allows for cost comparison over a span of years. (See Appendix B) The panel recommended the use of a 3% discount rate. Sensitivity analysis addresses the issue of uncertainty. (Weinstein et al, 1996 and Garber, 1999)

On reporting CEAs Siegel, Weinstein, Russell, and Gold stated the process must be standardized. Standardization allows for valid comparisons of C/E ratios. The business case analysis (BCA) is the Army's accepted method of reporting a return on investment (ROI) which Army medical facilities' consider to be a CEA.

Utility theory, developed in the 1940s by von Neumann and Morgenstern looks at quantifying uncertainty and is an integral component of cost effectiveness analysis. (Brown, Brown, Sharma, & Garrett, 1999) Utility values reflect the preference of a given patient for a particular outcome or choice. A utility value of 1.0 equates to perfect health and 0 equates to death. Torrance and Feeny, according to Brown et al, associated blindness with a utility value of .39. (Brown, Brown, Sharma, Kistler, & Brown, 2001) Legal blindness is defined as the Snellen visual acuity of ≤ 20/200 in either eye, therefore blindness could be perceived by a patient to be anywhere from a visual acuity of 20/200 to no light perception.

Utility measures are important as they can be used to provide an objective measurement of a patient’s preference. Brown et al (2001) found there is a wide range of utility values in relation to the range of legal blindness and the worse the vision in the better eye the lower the utility. There are two widely used methods for assigning utility values. They are time trade-off and standard gamble methods. The standard gamble method gives the patient, with the new treatment, the choice of either being returned to perfect health if the treatment works or immediate death (under anesthesia) if the treatment fails. The patient is then asked the percent of risk of death, if any they are willing to accept prior to having the treatment. The accepted risk is the value placed on the treatment. The time trade-off method asks the patient how many years they think they have remaining and how many of them they would be willing to give up or trade in order to have perfect health. The economist’s “gold standard” for assigning utility is the standard gamble method. (Brown et al, 2001)

Brown et al (2001) determined that patients did not understand the standard gamble method and it overestimates risk aversion when compared to other methods. They determined that even more important than which method to use that “utility values should be compared using the same method when contrasting utilities associated with different health states.” (p. 330) This study found that patients highly value their vision. Brown et al also found that the length of vision loss affects the utility value; therefore it is imperative that an ophthalmologist preserves what level of sight a patient has at the moment. A conclusion of this study was “visual loss associated with macular degeneration is comparable by utility measurement with that seen with diabetic retinopathy or cataract… the degree of visual loss in the better seeing eye, … is most directly correlated with a utility value.”(Brown et al, 2001, p. 331)

In a second study by Brown, Brown, Sharma, Landy, & Bakal (2002) similar findings were obtained on utility values. This study looked to evaluate the effect on utility values of secondary vision loss due to diabetic retinopathy. They used the

Visual Functioning 14 and Visual Functioning 25 Questionnaires, which were developed for measuring ophthalmic conditions but had not been used in cost-effectiveness analysis. The authors found this to be a

> critical factor in improving quality in an era in which the United States has been ranked by the World Health Organization as No. 37 in the world in its use of a method that measures the efficacy of health care resource expenditures. (Brown, Brown, Sharma, Landy, & Bakal, 2002, p. 484)

In analyzing their data they found a significant difference between the utility values of the two groups and that the contribution of visual acuity to utility values was significant. (Brown, Brown, Sharma, Landy, & Bakal 2002)

The utility assessment, developed by economists, provides a means to determine a person’s value of a given health state. Dr. Gary Brown studied the evaluation of the quality of life associated with varying ophthalmologic abnormalities. Brown (1999) found the change in the visual acuity of the better eye was more in line with the time trade-off utility value. He also noted that the time trade-off values were more statistically significant than the standard gamble values. Time trade-off value is calculated by: 1) asking the individual number of years they expect to live, 2) of those remaining years how many would he or she be willing to give up or trade in return for a perfect state of health, 3) assuming 1 equals optimal health, subtract proportion of years remaining from 1.0. For a person estimating to live 15 more years and willing to trade 5 of those years, he or she would have a utility value of 1.0 – 5/15, or 1.0 - .33 = 0.67. Using this method, higher is better. Secondarily, he noted the time trade-off value was more easily understood by the patients and therefore more accurate. (Brown, 1999) His findings as to the estimated utility values are in Table 2.

TABLE 2

Utility Values Associated With Visual Acuity in the Better Seeing Eye

Visual Acuity	Time trade Off	Standard Gamble
20/20	0.92	0.96
20/25	0.87	0.92
20/30	0.84	0.91
20/40	0.80	0.89
20/50	0.77	0.83
20/70	0.74	0.80
20/100	0.67	0.82
20/200	0.66	0.80
20/300	0.63	0.78
20/400	0.54	0.59
CF	0.52	0.65
HM-NLP	0.35	0.49
Overall	0.77	0.85

CF = counting fingers
HM = hand motions
NLP = no light perception

Note. The data in Table 2 are from Vision and Quality of Life, by G.C. Brown, 1999, Transactions of the American Ophthalmological Society, 97, p. 484.

Laupacis, Feeny, Detsky, and Tugwell (1992) conducted research on costs of adopting and utilizing new technology and determining guidelines for using clinical and economic evaluations. Laupacis et al used a cost-effectiveness model, validated in a prior study, to determine acceptable incremental costs versus incremental benefits. The model focused on five variables: total cost, target population at risk per year, sample size, rate of adverse event in control group per year, and estimate of risk reduction based on prior information. They determined, based on the quality of the methodology used in estimating clinical quality, costs, and quality of life technologies can then be placed into one of five categories as a grade of recommendation. The model showed that technologies costing less than $20,000 per QALY are considered cost-effective and are also readily accepted by the public and should be implemented where possible. (Laupacis, Feeny, Detsky, & Tugwell, 1992)

Javitt and Aiello (1999) conducted a study on the cost-effectiveness of detecting and treating diabetic retinopathy. They used the Prospective Population Health Event Tabulation (PROPHET) Modeling system, a simulation program based on Monte Carlo simulation. This simulation allows for multiple variables to be put in place over time to determine the effects on the probabilities of an event to occur. Javitt and Aiello looked at the dollars spent on a given treatment per Quality of Life (QALY) saved. A QALY is a "measure of the performance of medical treatments and interventions that captures in a single metric two important dimensions of medical outcomes: the degree of improvement of health, and the time interval over which the improvement occurs."(Freeman, Hammitt, & De Civita, n. d., p. 1) The value of "1 QALY" equals an increase of life expectancy by one year. Vision, in the 15-D Health-Related Quality of Life Index equals .075. (Jacobs & Rapoport, 2002) Due to their high index ranking, QALYs are useful in comparing the effectiveness of different treatments and are useful in cost effectiveness analysis to determine the efficiency of utilization of our medical resources. (Freeman, Hammitt, & De Civita, n. d.) According to Lee and Zhang, QALY is the standard for measuring utility in the Western countries. (Lee & Zhang, 2003) In using QALYs, three conditions must be met: the person must be risk neutral to any other mortality risk that does not affect his or her longevity; the amount of longevity traded to improve health does not impede his or her longevity; and risk preferences are not dependent on income. (Freeman, Hammitt, & De Civita, (n. d.)

In their study of retinopathy treatment, Javitt and Aiello utilized QALYs to determine cost-effectiveness of various interventions. They found, "over 413,200 person-years of sight are currently saved and over 710,800 person-years of sight could be salvaged if all diabetic patients had appropriate ophthalmic screening and treatment." (Javitt & Aiello, 1996 p. 166) They also noted that other medical interventions have not been as cost-effective as ophthalmic screening. The authors further evaluated ophthalmic screening using the levels of acceptance for new technologies as stated in the Laupacis et al studies. The findings were that health interventions costing less than \$20,000 per QALY were easily accepted and therefore should be adopted. Using this, Javitt and Aiello determined screening at the cost of \$1996 for those with IDDM and up to \$3530 for NIDDM should most definitely be adopted. Even with this knowledge screening remains grossly underutilized. (Javitt & Aiello, 1996)

Busbee et al conducted a study using the time tradeoff method for determining utility values for visual acuity. Utility values were again "shown to be directly proportional to the Snellen visual acuity in the better seeing eye." (Busbee, Brown, Brown, & Sharma, 2002, p. 607) This study looked at the initial outlays of money at the beginning of treatment and discounting to account for the time value of money. This study found that interventions costing less than \$20,000/QALY are highly cost-effective and those costing more than \$100,000 are not cost-effective.

In the study by Brown, Brown, Sharma and Garrett (1999) it was noted that when the QALY gained and the cost associated with the intervention to gain the QALY is known then the cost per QALY could be calculated. The number of QALYs gained can be calculated by multiplying the change in utility rating by the change in the number of years of life. This calculation of cost/QALY "allows consumers to evaluate the quality of what they are respectively purchasing and selling." (Brown, Brown, Sharma, & Garrett, 1999, p. 225)

A direct application of cost/QALY study was conducted in a James Bay, Ontario study on screening for diabetic retinopathy in a remote area. The study compared the "screening models and calculated total costs, visual outcome, costs per sight-year saved and costs per quality-adjusted life year." (Maberly, Walker, Koushik, & Cruess, 2003, p. 160) When comparing the cost of sending a specialist to the remote areas versus using a camera program, the camera program was preferred. The economic analysis included costs of personnel, transportation and equipment needed. Costs were discounted by 5% over a five-year period to determine the present value of money. Effectiveness of each program was represented by a QALY, calculated "from program specific probability models of visual outcomes and discounted by 5% yearly." (Maberly et al, 2003), p. 161) A QALY for a person with diabetes is estimated at .85 and with diabetic retinopathy, .59. In comparing the cost per QALY assigned, the camera program was the most cost-efficient by retaining the greater number of sight years while costing the least amount resulting in a

$15,000 cost/QALY. With sensitivity analysis up to 65%, the cost per QALY remains under the $20,000/QALY threshold. A final note from the study; the cost of buying and implementing the camera program by the 5-year period, became an insignificant factor. This study not only demonstrates the cost effectiveness of diabetic screening but also shows the effectiveness of digital photography for use in providing diabetic ophthalmologic care.

Teleophthalmology

On the Telehealth Technology Guidelines web page Dr Charles Flowers states "telemedicine is a natural extension of ophthalmology." (Flowers, n.d.) When instituting any telemedicine program it must incorporate three basic elements: "image/information acquisition, image/information management, and image/information display and presentation." (Flowers n.d., p. 1) There are four general principles that must be followed when conducting a telemedicine study: 1) determine the purpose for any telemedicine system, 2) ensure the system being tested meets the appropriate criterion standards, 3) establish the technical validity of the new technology, and 4) studies need to analyze the effect of implementation in the community. (Lee, 1999, p. 1639)

Implementation of teleophthalmology is a three-tiered strategy involving the local, regional, and potentially national levels. To determine the best camera system for all teleophthalmology, national standards need to be developed for governing image resolution, image display, and file compression. (Li H., 1999) Regional implementation focuses on establishing a regional reading center. This could be set up as a two-way communication system or as a spoke-and-wheel system.

Use of a digital camera to capture an image in a store-and-forward methodology is well established. For the posterior segment assessment of the eye, store-and-forward is the preferred method for assessment. Liesenfeld et al demonstrated in their study digital fundus photography for screening of diabetic retinopathy is a valid method. (Liesenfeld et al, 2000) This study compared the accuracy of a digital fundal photograph with that of an actual ophthalmic exam. A digital fundus camera was used to take two 50° digital images, which were reviewed by an ophthalmologist. A second ophthalmologist conducted an actual exam to evaluate the same patient. There was no significant difference in the evaluations of the two groups. The authors go on to note “screening costs would be expected to decrease, since no film material is necessary and compressed digital images preserve image quality.” Liesenfeld et al (2000, p. 348)

The Lee et al study found the digital imaging process is capable of reliably detecting retinal changes that occur with retinopathy. Retinal photos were obtained then run through a computer for analysis. Ophthalmologists then analyzed the photographs. The study concluded the “agreement rates, sensitivity, and specificity between the computer system and the human experts are comparable with those between human experts in detecting early retinal lesions.” (Lee et al., 2001, p. 515) The findings of these studies were substantiated in a third study, which found “fundus photographs are more reliable than ophthalmoscopy in the diagnosis of diabetic retinal lesions.” (Gomez-Ulla et al., 2002, p. 1385)

Store and forward (SAF) technology is well established and utilized extensively in the radiology field. SAF technology is much less expensive when compared to real-time, present technology. (Houston et al., 1999) While not all medical specialties can use SAF, ophthalmology can make full use of this economical technology. In addition, SAF allows for batching of transmissions which is less expensive and allows for more scheduling flexibility for both the patient and the provider.

Houston et al noted in their study that SAF allows the primary care provider to continue as the provider in charge for the patients overall care with input from specialists as needed without the need or expense of a second appointment. (Houston et al 1999)

A prime example in the usage of teleophthalmology is the Veterans Administration eye program located at Tripler Army Medical Center (TAMC) in Honolulu, Hawaii. The VA partnered with Joslin Vision Network (JVN), headquarters Boston, to establish a teleophthalmologic program. The intent of the project was and is to increase access to cost effective eye care across the spectrum. The program involves two components: JVN telemedicine technology and store and forward capability using the JVN system. Joslin presently uses an improved JVN system, called JVN3, and placed it in TAMC. As a result of the program's success the JVN3 system deployed to two remote clinics in the VA system: Hilo, Hawaii and Kahului, Maui. (Joslin Diabetes Center, 2003 and Darkins, 2001)

PURPOSE

The purpose of this study is to determine whether or not implementation of teleophthalmology in Primary Care clinics in GPRMC Military Treatment Facilities (MTF) is cost-effective or feasible. The hypothesis is that it is feasible or cost-effective to implement teleophthalmology in GPRMC.

METHODOLOGY

This project involves analysis from two separate aspects. The first aspect to be looked at is from the economic standpoint, or the cost effectiveness of implementing this project. The second aspect will be from the social standpoint, or how this new technology will impact the individual patient's quality of life.

The economic analysis will be accomplished by performing a business case analysis. This economic analysis will consist of five parts: 1) identifying the camera to be used, 2) assessing the information management infrastructure to include bandwidth and computer systems, 3) determining the number of diabetics in the region for estimating workload available for recapture or cost avoidance, 4) determining the net present value of future cash flows, and 5) determining the return on investment for the region. The social analysis will consist of two parts. The first part to be determined is the cost per visit; the second is the cost per QALY.

Economic analysis

The business case analysis (BCA) is the industry-accepted and MEDCOM approved method for making decisions on new projects or altering old ones. Based on the data entered, the BCA 5.3 Excel program Quad Sheet template (Appendix A) will estimate future cash flows, a series of net present values (NPV) using a 1.6% discount rate established by MEDCOM. There are four NPVs calculated by the BCA, one is for total expenses and one for each of the three cost benefit categories, and a single return on investment (ROI) figure. This multiple combining of information allows for sensitivity and specificity analysis as called for in any cost effective analysis. (Russell, Gold, Siegel, Daniels, & Weinstein, 1996)

The nature of a BCA, in general, is to identify all economic factors that affect the overall cost of a project. The BCA looks at workload (direct and purchased care), costs of equipment and/or personnel needed, possible maintenance costs for equipment, training, and possible travel expenditures for training on the use of the purchased system, information management infrastructure in support of a selected system, and any other identified money for anticipated return on investment, available space for the new technology, and the cost as well as space for supplies to support the new initiative. Not all areas mentioned are pertinent to any one BCA.

This project's BCA will focus on determining the amount of diabetic workload in the region, determining the amount of recapturable dollars or cost avoidance dollars available, and determining the start up costs for the project. The other areas mentioned are not included as they are not germane to the teleophthalmology implementation project.

The number of diabetics enrolled in TRICARE Prime under age 65 being provided care assists with determining the workload, which is the total number of visits for this project. This number will be calculated using the BCA's Workload template. The number of enrollees also assists with the calculations for determining the dollars available for recapture or for network dollar cost avoidance. The anticipated start-up costs will include: the camera system, the computer system for sending the films and establishing a regional reading center.

The BCA process covers a 36 month period. The BCA template Quad Sheet as in Appendix A shows the overall calculations for the BCA process. A series of individual templates are used to populate the Quad Sheet. The fiscal year (FY) for the start date of the project is noted followed by the number of months remaining in that FY the project will be in effect. Years two and three will be a full 12 months each and the fourth year will be the remaining months to equal 36 months. If year one had four months then year 4 will have 8 months. The FY preceding the implementation year is considered the base year. For this project the base year is FY 03 with a proposed start date in June). Projections for the remaining years are then calculated based on the percent of expected increase. The percentage is subjective and is based on the analysis of the data. The literature recommends a three percent increase per year. (Weinstein, Siegel, Gold, Kamlet, & Russell, 1996

The data source for the economic analysis is M2, formerly All Regional Server (ARS) Bridge. M2 is a "powerful tool used to obtain summary and detailed views of population, clinical, and financial data from all military health system regions." (Executive Information and Decision Support, 2003, p. 1) M2 will be used to obtain FY 02 and FY 03 direct and purchased care data.

Use of Excel pivot tables allows for data obtained from the identified database, by named individual fields, to be placed on a spread sheet for information extraction. Appendix B shows a sample pivot table ready for set-up. The pivot table allows the determination of the total number of visits and their associated costs the use of which will be explained later in detail.

The ophthalmology CPT codes identified for analysis to determine total visits are: 92250 – photo, 92002 – initial intermediate patient, 92004 – initial complicated patient, 92012 – established intermediate patient, and 90614 – established complicated patient. (Practice Management Information Corporation, 2001) To ensure capture of all appropriate data the International Classification of Diseases 9th Revision (ICD-9) diagnostic codes are also used. These codes are: a) 25050 (DM, type 2 NIDDM), 25051 (DM, type 1 IDDM), 25052 (type 2, NIDDM), 25053(type 1, IDDM), 36201 (background Diabetic Retinopathy); and 36202 (other Proliferative Diabetic Retinopathy). (Practice Management Information Corporation, 2003)

For this BCA the M2 fields identified for purchased care analysis are beneficiary category (all types); Bid-price adjustment MTF (MTF where enrolled for care); CPT (as identified previously); Other health insurance (OHI) raw; Primary diagnosis; Prime, Non-Prime, (P/NP/TFL) (looking at Prime only); Service type (outpatient only); Place of service (outpatient or doctors office); age <65; fiscal year (FY 02 and FY03); the sum of visits raw; and sum of paid raw. Paid raw is the amount paid to the network by the government for the visit.

The direct care fields identified are beneficiary category (all types), OHI; Procedure 1 (includes all diabetic CPTs and ICD-9 codes identified previously), age 64 and under; P/NP/TFL (Prime only), FY (FY02 and FY03), the sum of encounters, and sum of variable raw. Variable raw is the amount the direct care visit costs the MTF. This aggregated data will produce future utilization and cost projections, as well as potential savings in terms identifying dollars available for cost avoidance and cost recapture. (Russell, Gold, Siegel, Daniels, & Weinstein, 1996)

Camera Selection

The first area of concentration of the BCA process is selecting the camera. To determine the best camera to purchase a decision matrix will be used. The ophthalmologic digital camera needs to be capable of taking clear, concise, color pictures of the eye for screening of retinopathy. The preference is for a camera that does not require pharmacological dilatation of the pupil. This feature would reduce the cost to the service and minimize the inconvenience to the patient. Other features of the preferred camera would be one that is easily focused for correct alignment to obtain the desired images and is small and lightweight enough to be maneuverable. (Gomez-Ulla et al., 2002) Figure 1 is the matrix that will be used for this process. The evaluation criteria for comparison of each camera are 1) cost of camera, to include maintenance fees, 2) ease of alignment 3) weight of camera, 4) and required pupil dilatation for obtaining the retinal image. The preferred camera is the one costing the least, provides easy alignment, is low in weight, and requires a minimum of mm pupil dilatation.

Figure 1. Camera decision matrix

Camera		Evaluation Criteria			
		Cost (000)	Easy alignment	Wt	Pupil dilatation (mm)

Infrastructure Assessment

The second area of concentration is the information technology infrastructure. The information technology infrastructure used for transmitting digital images must be able to transmit at 1.5 megabits per second (Mbps) through either a wide-area network (WAN) or a local-area network (LAN) telecommunication line. The computer system used for viewing must have 96 megabytes of RAM, 2.1 gigabytes of internal hardware and a computer screen that allows a nine megapixel image. (Houston et al., 1999) Figure 2 below is the matrix to be used to identify system capability. For a system to be considered certified as acceptable all criteria must receive a Yes answer in the matrix.

Figure 2. Infrastructure criteria matrix.

Infrastructure	Evaluation Criteria				
	Band width (1.5 Mpbs)	Speed of processor	96 Mbts RAM	2.1Gbts Internal hardware	Monitor with 9 megapixel image

Diabetic population calculations

The third area of concentration is identifying as accurately as possible the average number of TRICARE Prime diabetics enrolled in GPRMC. Data for determining the average number of diabetics enrolled in Prime in GPRMC will be obtained from the Diabetic Clinical Practice Guidelines (CPG) Metric Reporting through the Patient Administration Systems and Biostatistics

Activity (PASBA) for a twelve month period. Appendix C is a graph that will be used to determine this average.

The first step is to obtain the average number of diabetics enrolled per MTF per month. To calculate this average, sum the monthly data for each MTF. Next divide the sum by twelve to obtain the average number of diabetics per MTF per month. This step is necessary as the population can change significantly over a period of one year. Averaging allows for the normal fluctuations in enrollment patterns to be recognized and allowed for.

The second step will be to determine the average number of Prime diabetics per month eligible for care in GPRMC. To calculate the average numbers of diabetics per month in GPRMC simply sum the average number of diabetics per month for the individual MTFs. This average identifies the number of Prime enrollees who by HEDIS measures will require an annual eye exam.

Net Present Value (NPV)

NPV is a profitability measure using discounted cash flows. If the NPV is positive, the project is profitable. The higher a project’s NPV the more profitable the project. Conversely, if the NPV is negative, the project is not profitable. An NPV of zero means the project’s profits are able to meet but not exceed the required return discount rate for that institution. "NPV is a direct measure of the contribution of the project to shareholder wealth." (Gapenski, 2001, p. 412) The BCA template at Appendix B will be used to show the cash flows for the project. The NPV is calculated by discounting the series of cash flows by the established MEDCOM discount rate of 1.6% using the function wizard in the Excel program. The MEDCOM discount rate was obtained from OMB Circular No. A-94 Appendix C posted on the Office of Management and Budget website. (Office of Management and Budget, 2004) This interest rate, the same rate as is used for treasury bonds, is based on economic assumptions regarding the FY 05 budget and is minus inflation. The matrix for NPV is as in Table 3.

Table 3. Projected project cash flows with NPV.

Year	2002	2003	2004	2005
Cash flow				
NPV	$0.00			

Return on Investment (ROI)

The ROI for the implementation of teleophthalmology in the region is a ratio that calculates the total regional amount of money received in relation to the regional amount of money invested and is reported as a percentage. The ratio is the amount of profit divided by the amount of money invested times 100. An example calculation is ($70,000/$1,000,000) x 100 = 7%. ROI is the most frequently used measure for a project's performance. (Finkler & Ward, 1999; Weinstein, Siegel, Gold, Kamlet, & Russell, 1996) The BCA template provides the calculation of the ROI for the project. The ratio the BCA template itself provides is a savings to investment (SIR) ratio. The SIR is calculated as total revenues/total expenditures. The BCA template notes that if the SIR is less than 1 it is a negative ROI.

Table 4. Project ROI

Total revenues	Total expenditures		ROI
		x 100	

Social analysis

According to the literature the social ramification analysis must be addressed for all new medical treatments. This will be addressed by looking at the Quality Adjusted Life Year (QALY). This is an essential metric for cost effectiveness analysis for a given proposed treatment. (Lee & Zhang, 2003; Maberly, Walker, Koushik, & Cruess, 2003). This analysis is a two step process:

Step 1 is to determine the project's cost per visit using the project's total number of visits as identified by the BCA Workload template as discussed in the economic analysis section and Step 2 is to determine the cost per QALY.

Cost per visit

Determining the cost per visit for diabetic Prime enrollees is in two steps. Step one is identifying the data source and identifying the total number of visits. The second step is calculating the cost per visit.

Step One

The first step will be to identify the data source and utilizing the appropriate diabetic CPT and ICD-9 codes used during the economic analysis. These codes are identified on page 42.

Step Two

To calculate the cost per visit the first step will be to determine the total number of visits. The total number of diabetic related CPT and ICD-9 codes seen for care is annotated on the BCA Workload template as the total number of visits. This number will be obtained from the BCA Workload template using the total number of visits from Year 4. This number is cumulative;

it represents the amount of visits seen in Year 1 with incremental increases over the remaining time period. The incremental increases reflect the number of diabetics in GPRMC that are projected to be brought back into the system.

The second step will be to identify the total cost for providing this service. The total cost will be obtained from the BCA Quad Sheet under the column identified as outflow total. This figure is the cumulative cost for the project over the 36 month period. Finally, the total cost will be divided by the total number of visits to obtain cost per visit.

Table 5. Calculations for cost per visit.

Total cost	Total visits	Cost /visit

Once the cost per visit is determined the next step in the social analysis, cost per QALY, will be calculated.

Cost per QALY

The cost/QALY will be calculated by taking the cost per visit and multiplying it times the visual acuity assigned QALY. The assigned QALY will be taken from the statistically proven vision QALYs from Dr. G. C. Brown’s study in Table 2. The equivalent utility values associated with visual acuity of 20/100 through Hand motions/no light perception (HM-NLP) will be used to determine the cost per QALY for each level of acuity. (Brown, 1999) The use of the matrix will allow for ease of analysis of the results. Each level of acuity will be analyzed as to its cost effectiveness. The costs per QALY will then be compared to the literature implementation standard of $20,000 cost per QALY. For this project, only if all the costs per QALY identified in the matrix are less than $20,000 per QALY should the project be implemented.

Table 6 shows the matrix for determining the cost per QALY. Once the cost per visit is determined the amount is placed in the matrix then multiplied by the associated QALY to obtain the cost per QALY.

Table 6. Calculations of Costs/QALY

GPRMC		Cost/Visit
		$0.00
Acuity	QALY	Cost per QALY
20/100	0.67	
20/200	0.66	
20/300	0.63	
20/400	0.54	
CF	0.52	
HM/NLP	0.35	

Prior to conducting the regional BCA a beta project was conducted to test the proposed tools and methodologies. The teleophthalmology beta project was conducted using data from the BAMC ophthalmology clinic utilizing a digital camera and one technician for FY 02 and FY 03. The use of the new technology allowed the clinic to show an increase of approximately 300 known diabetic visits in one year. Overall the ophthalmology clinic was able to increase its total visits from 24,740 in FY 02 to 28,232 visits in FY 03. Personnel hired for the demonstration project consisted of one digital photographer at $18.00 per hour or $ 74,000 per year. A military provider assigned to the clinic did the formal readings. No other personnel were needed by the clinic to continue to provide the same if not increased level of quality care to all clinic patients. The marginal cost for the clinic in FY 02 was $23.19 and even with the added workload the marginal cost dropped to $20.76 in FY 03. This indicates no increase in the amount of supplies needed to provide the same care in fact the clinic became more cost efficient with the added workload. The clinic also increased its HEDIS compliancy rate from 61% to over 70%. While this improvement is notable it still falls short of the Army Surgeon General’s goal of 90% compliance for annual eye exams for diabetics. Due to the positive results the ophthalmology clinic continues to use the photographer and the new technology.

The beta project's findings based on the economic analysis of the data showed the project to be profitable. The project had a positive total net present value of over $86,000 and provided a return on investment of 32%. The savings to investment (SIR) ratio used in the MEDCOM BCA template was 1.32 indicating a positive ratio and for every one dollar spent the project made $32. The positive SIR showed the project was suitable for venture capital dollar funding. The social analysis provided a cost per visit of $740.44 and a cost per QALY in a range from high to low of $469 to $259. Since both the cost per visit and cost per QALY were significantly less than the $20,000 cost per QALY recommended for implementation, the impact or usefulness of these metrics when making a decision on whether or not to implement the project region wide were negligible.

The detailed data analysis of the project demonstrated the validity and reliability of the tools and methodologies used. The results suggested this project should be implemented on a regional basis and would result in a positive NPV and a positive ROI. This however, did not occur. One of the main reasons the regional project did not have a positive NPV or ROI is due to the lack of workload to offset the costs of implementation which will be discussed in more detail later.

RESULTS

Economic Analysis

Data results placed in the BCA template with FY 03 as the base year, proposed incremental increases for total workload, and all costs associated with implementing teleophthalmology were used to perform the economic and social analysis of this project. The economic analysis determined the camera to be purchased; assessed the information management infrastructure to include computer systems; determined the NPV, the ROI, and the SIR. The social analysis calculated the cost per visit and the cost per QALY. The data for direct care and purchased care for FY 02 and 03 were pulled from M2 for analysis. Appendix E shows the MTF and GPRMC aggregated results for FY 02 and FY 03 with individual yearly totals then combined FY 02 and FY 03 totals. Pivot tables were used to provide multiple ways to view and sum the information. FY 03 totals were then placed in the appropriate base year sections of the BCA template with the final computations noted on the BCA Quad Sheet. See Appendix F for the completed teleophthalmology BCA Quad Sheet.

From the Excel BCA template results the NPV and ROI for this project were calculated. Data included in this template are costs for personnel hires, cost of equipment, marginal costs, recapturable supplemental and purchased care dollars, dollars from cost avoidance, and third party reimbursement. Personnel hires included the retinal specialist with two support personnel for the reading center established at BAMC. No other personnel hires are needed to initiate this technology. Equipment costs included the camera with maintenance costs included in purchase price, an upgrade in computer systems, and purchase of an appropriate viewing monitor.

Recapturable workload dollars are those dollars spent when sending the patients out into the network to obtain a service not provided by the MTF. Recapturable workload dollars were calculated by first determining the FY 03 in-house base year workload and increasing by an estimated 25% each year for the next three years. The 25% projection is based on historical performance data with other telemedicine initiatives in GPRMC. Mr. Gary Crouch, Director of Telemedicine at GPRMC confirmed this is an appropriate percentage for determining workload for a new telehealth treatment with no historical data. Obtaining the 25% increase will be assisted by the new managed care contracts whose emphasis is placed on keeping workload in the MTF.

Another method to address recapturing workload is to develop an advertising plan. A first step is to advertise or sell the new service to the primary care providers who can then in turn assist in selling the idea to their patients. Ophthalmology providers should like it as it will free up appointments for other more serious or complex cases, and again, keeps workload in the MTF. A second step is to seek volunteers among the desired population to try the new treatment. As the service allows for a second visit to the hospital for an eye exam to be eliminated; no eye drops for pupil dilatation used; and therefore no bulky sun shades needed the patients will like it and will tell their friends about it. The volunteers, by word of mouth, then become the best advertisement for the new service.

While the estimate of 25% is conservative and there is capacity to recapture all those sent out to the network for care it is however, not prudent to assume a project can bring back all workload sent out to the network. Many patients, for instance, will prefer to stay with a provider with whom they have an established relationship. Cost avoidance dollars are those dollars associated with new patient appointment expenses we can now keep in-house, but would have gone out to the network prior to the new service implementation. In both instances supplemental care refers to network care provided active duty beneficiaries, all others (active duty dependents, non-active duty dependents and eligible retirees) are referred to as CHAMPUS.

Camera analysis results

The decision matrix was used to determine the best camera for the project. Equipment costs for this project included one camera and its maintenance costs. Of the six cameras screened two were eliminated due to not meeting criteria for size (too large) and ease of alignment (called for sophisticated user). The remaining four cameras were placed in the decision matrix, per criteria. Cost was most important, size of camera (smaller is better, take up less space), ease of alignment, and pupil dilatation in mm. Figure 3 shows the comparison of the four remaining cameras.

Figure 3. Camera decision matrix

Camera	Evaluation Criteria			
	Cost (000)	Easy alignment	Wt	Pupil dilat ation (mm)
Canon CR6-45NM	22	Yes	24	4
Topcon TRC-NW6S/6SF	30	Yes	26	4
Topcon TRC-50EX	30	Yes	37	4
Kowa RC-XV3	30	Yes	43	4

The camera chosen by the BAMC Ophthalmologist is the Canon CR6-45 Non-Mydriatic Retinal Camera. This camera was chosen for cost, weight/size, and its easy two-step alignment to obtain accurate eye photographs. (Unknown, n.d.) A camera of this type was used in a study by Peters, Davidson, and Ziel and demonstrated "sensitivity was 100% and specificity was 82% for diagnosing serious diabetic retinopathy". (1993, p. 1193) Peters et al also noted that with proper usage a non-mydriatic (nm) camera has the potential to identify more patients at risk for serious DR. A second advantage to using the nm camera is that there is a permanent record of the patients' eye status, which is useful for tracking the individual patient's disease state. (Griffith et al., 1993)

Infrastructure analysis results

The computer equipment was assessed for its ability to meet the stated criteria. The findings were as follows.

Figure 4. Infrastructure Evaluation Results

Infrastructure	Evaluation Criteria				
	Band width (1.5 Mpbs)	Speed of processor	96 Mbts RAM	2.1Gbts Internal hardware	Monitor with 9 megapixel image
	Yes	Yes	Yes	Yes	Yes

Based on the all yes answers in the matrix the computer system presently in place was determined as certified for usage for the demonstration project. However, to establish the regional teleophthalmology reading center, a step beyond the beta project, the computer system and workstation requires an upgrade. The information management and information technology bandwidth infrastructure presently in place for the other telehealth initiatives meets the standards for and is capable of transmitting at 1.5 megabits per second (Mbps) through either a WAN or a LAN telecommunication line for transmitting of teleophthalmology pictures.

Diabetic population results

Appendix D identifies the average number of diabetics in GPRMC who require and are eligible for annual eye exams. On average GPRMC has 8,809 diabetics enrolled in Prime and eligible for an annual eye exam.

NPV

For the 36 month period the cash outflows by year are as follows: FY03 1, ($311,900); FY 04, ($325,700); FY 05, ($275,600); and FY 06, $90,600. Negative numbers, as noted by the use of the parentheses indicates an outflow or loss of dollars for the project. The NPV for the project is negative ($800,267) indicating the project is not profitable. Table 7 shows the cash flows for this project.

Table 7 Cash flows with present values and NPV.

Year	2003	2004	2005	2006
Cash flow	($311,900.00)	($325,700.00)	($275,600.00)	$90,600.00
NPV	($800,267.88)			

ROI

For the 36 month period the total cash outflow is $1,207,200 and a total cash inflow of $365,100 for a total net loss of $842,100. The BCA template refers to this result as the ROI. The ratio the BCA template provides is a savings to investment (SIR) ratio. The SIR for the project is .30 calculated as total revenues/total expenditures. The BCA template notes that if the SIR is less than 1 it is a negative ROI. The financial analysis accepted measure for calculating the ROI is total profit divided by total expenditures X 100. The industry accepted ROI for the beta project is a negative 68%. The calculations are as seen in Table 8. The ROI is showing that for every one dollar invested into the project we are loosing approximately $70.

Table 8. Calculated ROI

Total profits	Total expenditures		ROI
($822,500)	$1,207,200	x 100	(68.13)

SOCIAL ANALYSIS RESULTS

Cost per visit

Table 9 shows the calculation of dividing the total cost of the project by the total visits. From the BCA Workload template the resultant cost per visit was $821.22. This completes the first step in the social analysis.

Table 9. Cost per visit calculation.

GPRMC		
Total cost	Total visits	Cost /visit
$1,207,200.00	1470	$821.22

Cost per QALY

The second step of the social analysis is the cost per QALY. Table 10 shows the associated costs per QALY for the acuity levels assigned to levels of blindness. Since all results are less than $20,000, according to the literature this project should be fully implemented. However, due to the overall cost per visit being less than $20,000 the usefulness of this metric is questionable.

Table 10. Costs per QALY calculations.

GPRMC		Cost/Visit
		$821.22
Acuity	QALY	Cost per QALY
20/100	0.67	$550.22
20/200	0.66	$542.01
20/300	0.63	$517.37
20/400	0.54	$443.46
CF	0.52	$427.03
HM/NLP	0.35	$287.43

A non-financial aspect analyzed was the usefulness of this project in assisting BAMC in meeting The Army Surgeon General's (TSG) balanced score card (BSC) or strategic goals. This project assisted in supporting several goals or bubbles on TSG's BSC. Three supported goals identified are Manage the Care of the Soldier and the Military Family (C-10 Hassle-Free Environment), Manage and Promote the Health of the Soldier and the Military Family (F-3 Optimize Total (MCSC + Direct) System Efficiency), and Learning and Growth (L-2 Leverage Information Management and Medical Technology). (Great Plains Regional Medical Command, 2004)

DISCUSSION

The project's economic analysis, based on the data analysis of the M2 data obtained for this project, indicates teleophthalmology is a service that should not be implemented as it has a negative ROI and is therefore not fundable using venture capital monies. The project's social analysis however, indicates that teleophthalmology is a service that should be implemented. It utilizes a technology that improves the provision of the annual eye screening for diabetic eye care. The question for the regional commander is whether or not the cost is worth implementing the project.

While teleophthalmology does not qualify as a venture capital project due to its negative ROI it does however, qualify as a clinical deficiency project. The teleophthalmology project meets the three criteria established, by MEDCOM to qualify for clinical deficiency project funds. The criteria are 1) the clinical deficiency must be a TRICARE benefit; 2) lack of service has caused or is likely to cause negative healthcare outcomes; and 3) services with acceptable access time and quality are not available to beneficiaries in the catchment area.

The first criterion is a strictly yes or no answer and for this project the answer is yes. An annual eye exam is a well established benefit as it is a HEDIS requirement for providing full care for the diabetic patient. The annual eye exam is also a major component of the Army's Clinical Practice Guideline on diabetes.

The second criterion addresses the ramifications if a service is not provided. As noted in the literature, failure to have annual eye exams to monitor the status of the retina for diabetics can and will lead to loss of vision. Loss of vision in turn leads to more expensive health care as well as a decrease in the patient's quality of life as denoted by the QALY assigned to the lowest vision acuity. There is an added cost to the patient as he or she must modify their living arrangements to meet their needs. There is an additional cost to the MTF providing the care as the patient now requires special equipment and educational resources to provide that care. There is an additional cost to the government for disability pay as the loss of vision has decreased their ability to work and make a living to pay for their needs of daily living. By offering teleophthalmology the regional MTFs can increase their ability and ease of obtaining an annual eye exam for their diabetic patients. The more closely the vision status is monitored the more rapidly the provider can institute measures to correct or limit the damage done by the diabetic retinopathy process. Limiting the extent of the disease process delays the time when increased resources and costs will be required.

Javitt in his 1994 article on preventive eye care for diabetics noted that “the total annual federal expenditure of $14,296 is predicted for blind patients with diabetes who are less than 65 years of age.” (Javitt & Aiello, 1994 p. 910) These figures are based on 1994 dollars at a 5% discount rate. Assuming that 177 (2%) of those eligible, according to PASBA, for GPRMC care become eligible for disability pay due to poor vision at a cost of $23,287 per person, a 5% discount rate for subsequent years, this equals $4,121,799 in potential expenditures. Mitigating this expenditure would more than pay for the implementation and sustainment of teleophthalmology.

The third criterion of acceptable access time is well addressed by teleophthalmology. Traditionally the patient must see their primary provider then make a second appointment with the ophthalmologist for a later date to have their retinas checked. Teleophthalmology allows for all this to be done in one visit with the primary provider. The ease of obtaining the annual eye exam will increase the HEDIS compliancy rate for the requirement of an annual eye exam for diabetics. As stated previously, close monitoring and early intervention decreases the cost of providing care or at the least delays the time when the increased cost will be required due to the loss of vision.

A secondary issue regarding acceptable access time is related to the number of ophthalmologists available on Active Duty not just for GPRMC but for the MEDCOM as a whole. At present there are a total of 64 ophthalmologists in the MEDCOM inventory. If the number of ophthalmologists continues to decrease at its present rate of 4 to 7 per year then there will soon be few MTFs that will have this specialty capability resulting in more care being sent out to the network causing an increase in the cost of care for each patient. In the new era of TRICARE Next Generation of Contracts where the MTF is paid a set per member per month fee for the care of each enrollee the increased workload sent out to the network could end up costing the individual MTF more than the implementing costs of teleophthalmology.

From the data analysis we know that the project is not economically the correct thing to do. Based on the beta project at BAMC the project should have been profitable. The question then becomes why did the BCA analysis not have a positive ROI.

One of the biggest and most important steps in doing any BCA is determining the anticipated workload. This is normally calculated from historic data. However, this is a new service and there is no historical data for teleophthalmology. The alternative chosen to determine this workload was to use diabetic visit data augmented by the average number of diabetics per month in GPRMC. A limitation of this study is the imprecise determination of the number of diabetics in GPRMC. An essential factor in a BCA is the ability to determine recapturable workload. This number is reflected in the amount of increased direct care as well as the decreased amount of purchased care all of which has an effect on the NPV and the ROI. Therefore the average number of diabetics in GPRMC for this project may be undercounted and lead to an inaccurate accounting for cost recapture and cost avoidance monies.

Determining the number of Prime eligible diabetics in the region to assist in calculating the total number of diabetics GPRMC is responsible for proved problematic. The avenue identified to determine the workload was two fold in nature. The first step was to obtain M2 data for diabetic care using the identified ophthalmic CPT and ICD-9 codes discussed on page 42. The data obtained was for care provided both in-house and in the network. The workload in-house served as the base number. A percentage of those sent out to the network plus any others eligible for eye exams was used to determine the projections for the new workload.

Data for determining the average number of diabetics enrolled in Prime in GPRMC was obtained from the Clinical Practice Guidelines (CPG) Metric Reporting through the Patient Administration Systems and Biostatistics Activity (PASBA) website for December 02 through November 03. Appendix D, as discussed earlier shows the calculated average number of diabetics per month in GPRMC. The average numbers of diabetic Prime enrollees identified are those who require and are eligible for annual eye exams. In GPRMC the numbers ranged from 8,426 to 9,234 with an overall average for this period of 8,809. The MTF with the fewest diabetics is Munson Army Health Center (MAHC) with an average of 310 per month. The largest diabetic population other than BAMC with 2,366 per month is Darnall Army Community Hospital (DACH) with an average of 1,336 per month. From this template's results we know the region has the potential for performing, on average 8,809 diabetic annual eye exams.

The problem with the PASBA statistics is that they are based on the number of diabetics who have obtained an Hgb A1C in a two year period using the Standard Inpatient Data Record and Standard Ambulatory Data Record. This data does not include gestational diabetics, another potentially large population. In looking at the PASBA Hgb A1C <9.5 metric, it only addresses of those who received an Hgb A1C test how many were below 9.5. This number is a subset of those receiving Hbg A1C and does not help to clarify the total number of diabetics in the region. Again, this becomes important when attempting to determine the real number of diabetics in the region for purposes of looking at workload. It is impossible at this time to tell how numerous the diabetic patient workload is. As of 1 March PASBA no longer captures diabetic CPG data. In future another database used for monitoring these required metrics will need to be found. One possible database is the Air Force Population Health database. The accuracy and usage of any new database is the subject of a different study and not in the purview of this paper.

A second issue found when attempting to determine the number of diabetics for purposes of workload is the large difference between the number identified as being eligible and the amount of documented workload in M2. This large discrepancy makes anticipating the true recapturable and capturable (cost avoidance) workload difficult. As an example, DACH has according to PASBA an average of 1336 diabetics eligible for an annual eye exam; the M2 data for both direct and purchased care shows a workload for ophthalmic eye care to include a retinal exam of 99 for FY 03. Who and where the patients that fall into this gap are is the big question. As stated previously there is presently no way to identify and capture this data. Therefore to ensure the projections for the project were not over inflated a 25% per year increased workload was used as a conservative estimate. This percentage best represents the minimum number of patients that could be recaptured or anticipated for cost avoidance dollars.

The analysis of the project’s findings as indicated previously was less than expected. While overall the project has a negative NPV the projected losses continually decrease and by the last eight months there is a savings of $90,600. The cost per visit steadily drops from $826 in year 1, $304 in year 2, $294 in year 3, down to $41 in year 4. However it must be noted that Year 4 is not a full year's salary which will artificially decrease the cost per visit. The cost per QALY per year at the 20/100 acuity level, the first level of blindness ranges from $553 in the first year down to $197 in year 3.

The regional BCA's cost and workload figures were calculated in the following manner. The personnel costs were based on the hiring of one ophthalmologist or retinal specialist and one technician as a film triage assistant for a total package deal of $230,000. A second technician hired as a General Service level 5 hire at a cost of $74,000 per year. No further personnel costs were expected. The staff presently employed at the MTFs could obtain the needed images for transmitting to the reading center. The base marginal supply costs were taken from the BAMC ophthalmology study. While this may be an inflated amount compared to the average Primary Care or Family Practice Clinic it is more in line with an Internal Medicine Clinic. Since this technology is being used in both the increased cost was used to represent a worse case scenario. The marginal supply costs were increased yearly by 3% as recommended by the literature. The other costs were the costs of four cameras and the computer system upgrade in the first year followed by the purchase of four cameras per year for the next two years. This would provide at least one camera per MTF although the deployment of the cameras may be different than one per MTF. During the deployment it may be better to send two or three cameras to one MTF and establish the service before attempting to set it up in another MTF.

The dollar amounts associated with cost recapture and cost avoidance are determined in a similar manner. In year one there is no cost avoidance dollars as the files and tables for appointments are fixed and cannot be changed. Starting in year 2 however the cost avoidance was calculated as number of base patients using a 25% increase each year, as established by previous GPRMC telehealth initiatives with the cost per visit at the average CHAMPUS Maximum Allowable Charge (CMAC) rate of $76.62. The average CMAC rate was calculated by taking the CMAC charge for the five of the six identified ophthalmic CPT codes with assigned CMAC rates for FY 03, summing them then dividing the total by five.

The camera identified in the results section, Canon CR6-45 Non-Mydriatic Retinal Camera requires minimal training to allow an appropriate retinal film to be obtained for interpretation. Training on use of the camera can be conducted while on-the-job, no special training sessions are required. This allows for rapid deployment and usage of the camera.

Due to the number of telemedicine initiatives and the high volume of usage, GPRMC's facilities already have the appropriate bandwidth, technological infrastructure, and information management support staff to ensure implementation and sustainment of the system.

With the camera selected and the information management infrastructure in place to support the initiative the question then becomes where and how to implement the project if approved for funding.

The plan for implementing teleophthalmology has several factors it must consider. These factors include determining the MTF in which to start the project and the clinic or clinics it needs to be in, determining the patient flow, establishing the reading center, finding a project champion to assist with conversion to the new service, and teaching the public about the new technology to obtain their compliance and acceptance of it.

The implementation plan is to utilize the ophthalmic digital camera in the clinics where adult primary care is provided. This could be any Primary Care Clinic, Family Practice, or Internal Medicine Clinic. The reading center would be at BAMC where they have the skilled specialist and the appropriate reading equipment for interpreting the retinal pictures.

The patient flow in the clinics, as per Figure 5 would not be heavily impacted. The diabetic patient would present to the clinic as usual and receive the initial assessment as do all other patients. The difference would be they would then go to a room where the lights are dimmed to allow for pupil dilatation and the required eye photographs taken. The majority of patients will not require any special eye drops to help with pupil dilatation. The lack of eye drops will decrease supply costs as the clinic will not need to store the medication or the sun glasses used to shield the eyes from bright lights. Taking the photographs at this time still allows the provider to do an eye exam if he or she wishes to do so. Utilizing this technology will increase the total number of appointments available in the ophthalmology clinic as most of all of those presently used for diabetic eye exams will not be needed. It will also decrease the diabetic no show rates, presently a 10-12% rate in ophthalmology which means more open appointments for other eye services and treatments.

Figure 5.

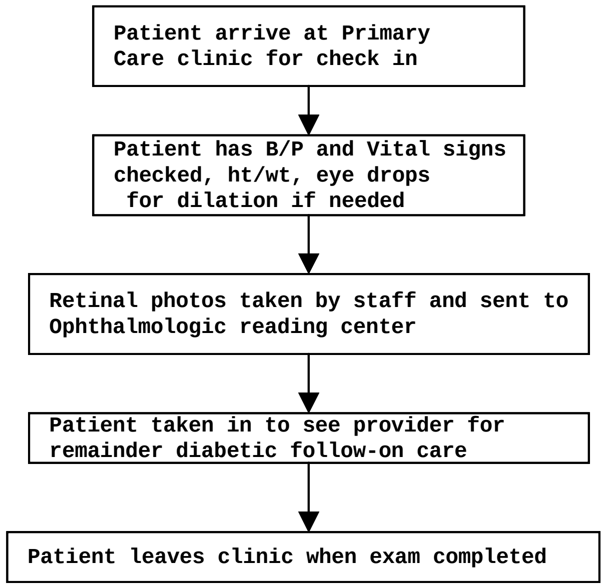


Figure 1. Patient flow through Primary Care Clinic using ophthalmic digital photography.

The reading center will be located in the BAMC Ophthalmology clinic. The estimated time to read a patient's eye film is three minutes, which allows for a ten-minute visit per patient for workload count. This workload count would be entered into MEPRS under the ancillary (D) account. The interpretation can not be counted as a visit in the B account as there is no direct interaction with the patient. This is similar to how workload for the radiologist is captured for film interpretation.

However, to establish the teleophthalmology reading center's computer system and workstation the present computer system will require an upgrade to a 3GHz processor, a 1GM RAM, two Serial ATA (SATA) 80GB hard drives with SATA controller, and CDRW. The monitor required and chosen is a 22.2in screen, T221 flat panel monitor that provides a 170-degree viewing angle, a maximum resolution of 3840 X 2400 pixels per inch and 1 to 400 contrast ratio. The cost of this monitor is $8,399. A computer system upgrade is being negotiated in a package deal for the PAC system in place for teleradiology at cost of $3,100 per workstation.

A non-financial aspect to be analyzed is how this project assists GPRMC in meeting The Army Surgeon General's (TSG) balanced score card (BSC) or strategic goals. This project is applicable to or supports several goals or bubbles on TSG's BSC. Three supported goals identified are Manage the Care of the Soldier and the Military Family (C-10 Hassle-Free Environment), Goal 3: Manage and Promote the Health of the Soldier Family and the Military Family (F-3 Optimize Total (MCSC + Direct) System Efficiency), and Learning and Growth (L-2 Leverage Information Management and Medical Technology). (Great Plains Regional Medical Command, 2004)

CONCLUSIONS AND RECOMMENDATIONS

Implementation of teleophthalmology is a feasible endeavor for Great Plains Regional Medical Command and is therefore recommended. Whether venture capital or clinical deficiency dollars are used to fund the program utilizing this technology is the right thing to do for our soldiers and beneficiaries. With the number of diabetics growing each year, the overall cost of health care increasing, reimbursements for military health services capitated, and the eventual financial cost of providing the means of daily living for those who are blind escalating, it only makes sense to use the technology available that will save sight years and decrease costs.

Many medical facilities, including MTFs are looking to implement new laser treatments to assist patients with correcting generally non-disease generated decreased visual acuity. Instead of investing monies into treatment regimens such as Laser In-Situ Keratomileusis (LASIK) or Photorefractive Keratotomy (PRK) programs as a new benefit for ADD and NADD beneficiaries these monies should be spent on improving access to an already recognized benefit of annual screening. The cost of one screening at $114.14 (highest CMAC rate for eye care) for 8,800 diabetic population in comparison to 2% receiving the $23,287 per year for sight disability pay equates to $1,004,432 for all annual eye exams versus $4,121,799 for 176 (2%) of the diabetic population for one year. The screening cost will actually be much less since over 50% of screenings are non-complicated in nature and therefore cost less.

As part of the implementation process the recommendation is for the purchase of the Canon CR6-45 Non-Mydriatic Retinal Camera for use in the designated primary care clinics at each of the MTFs in GPRMC. A second recommendation is to stagger the purchases of the cameras over a three to four year period of time. This allows for full implementation at one MTF before beginning at another and it allows for any errors or problems in the system to be worked out. The third implementation recommendation is to start the project at DACH, Fort Hood as they have the next largest population of diabetics and begin with placement of the camera in the Internal Medicine Clinic.

A recommendation for further study is to repeat this study’s BCA to include quantifying the social advantages. Quantifying these social advantages may actually change the economic assessment of implementing this new service.

A second recommendation for further study is to determine what other patients might benefit from this technology and combining the data with the diabetic data to see if the project would then have a positive ROI for venture capital funding.

There is a potentially large unknown population that would benefit from this type of close screening.

A further recommendation for the region, and even more importantly for the military, is the need for further studies into the usefulness of this technology for readiness. A study to determine the cost of providing a digital image of an individual soldier’s eyes prior to deployment needs to be done. With the numerous blast injuries to the eyes and potential for other eye injuries, such as a laser injury the military needs to determine the level of care that can and should be provided, where it should be provided, and the best means of providing that health care to the soldier who sustains an eye injury on the battlefield. Immediate and appropriate care provided without delay could save the soldier his or her eyesight. If appropriate care in the theater, if not the battlefield is available, will result in increased morale of the soldier.

In conclusion, utilizing teleophthalmology is the right thing to do. While, in the MEDCOM traditional cost effectiveness analysis the program is a money loser, when adding in the benefits to the military society as a whole it is a money winner. With a small and potentially decreasing supply of Active Duty Ophthalmologists, optimization of their capabilities is a must. In addition, ensuring easy accessibility to an annual eye exam will assist with early intervention for retinopathy complications and, in the long run, result in saved light years and decreased costs to everyone.

APPENDIX A

GPRMC DIABETES DATA Enrolled in Prime

	DEC 02	JAN 03	FEB 03	MAR 03	APR 03	MAY 03	JUN 03	JUL 03	AUG 03	SEP 03	OCT 03	NOV 03	AVG
BJACH													
BAMC													
DACH													
EACH													
IACH													
GLWACH													
MAHC													
RWBAHC													
RACH													
WBAMC													
GRAND TOTAL													

Note: Clinical Practice Guidelines (CPG) Metric Reporting through the Patient Administration Systems and Biostatistics Activity (PASBA)

APPENDIX B

BCA Quad Sheet Template

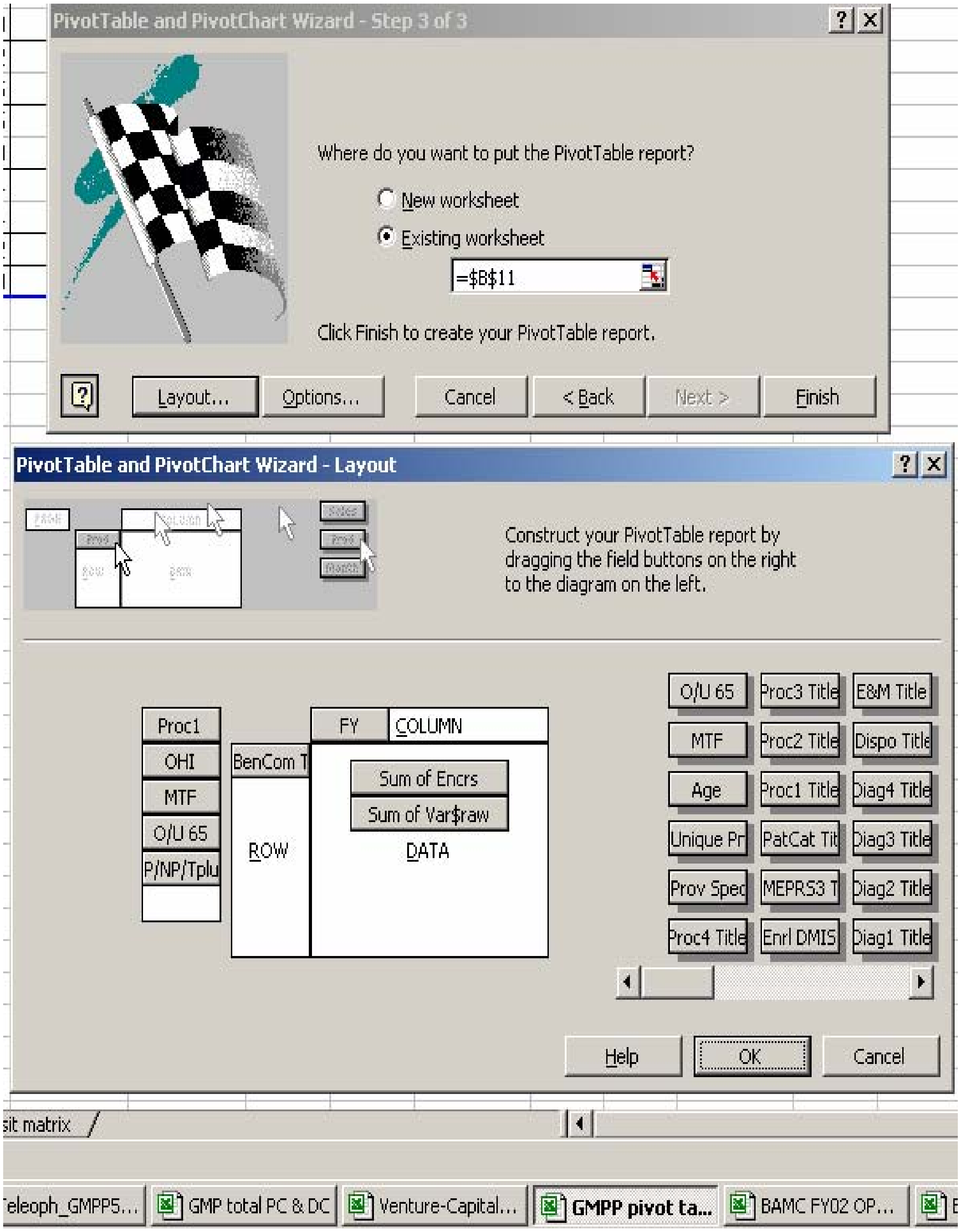
Net Savings & Loss Calculations ($000)							
	Net Present Value (NPV)	Fiscal Year	Year 1	Year 2	Year 3	Year 4	36-Month Program Total
		# of Months	6	12	12	6	<--- = 36 Months
Savings to Investment Ratio (SIR)		Personnel (Linked)	0.0	0.0	0.0	0.0	
		Travel (Linked)	0.0	0.0	0.0	0.0	
		Leases/Rents (Linked)	0.0	0.0	0.0	0.0	
		Contracts (Linked)	0.0	0.0	0.0	0.0	
value < 1		Marg. Supplies (Linked)	0.0	0.0	0.0	0.0	
is a		Equipment (Linked)	0.0	0.0	0.0	0.0	
Negative		Facility Mod (Linked)	0.0	0.0	0.0	0.0	
ROI		Misc. (Linked)	0.0	0.0	0.0	0.0	
	NPV	Other (Not Linked)	0.0	0.0	0.0	0.0	Outflow Total
	$0.0	**Requirement**	**0.0**	**0.0**	**0.0**	**0.0**	**$0.0**
	Benefits Cost Avoidance	MSCS (Not Linked)	0.0	0.0	0.0	0.0	
		Rev Financing (linked)	0.0	0.0	0.0	0.0	
		CHAMPUS A&O (linked)	0.0	0.0	0.0	0.0	
		TFL > 65 (linked)	0.0	0.0	0.0	0.0	
		Supp Care (linked)	0.0	0.0	0.0	0.0	
	NPV	Other (Not Linked)	0.0	0.0	0.0	0.0	
	$0.0	**Cost Avoidance**	**0.0**	**0.0**	**0.0**	**0.0**	
	Benefits PSC Savings	MCSC (Not Linked)	0.0	0.0	0.0	0.0	
		Rev Financing (linked)	0.0	0.0	0.0	0.0	
		CHAMPUS A&O (linked)	0.0	0.0	0.0	0.0	
		TFL > 65 (linked)	0.0	0.0	0.0	0.0	
		Supp Care (linked)	0.0	0.0	0.0	0.0	
Discount	NPV	Other (Not Linked)	0.0	0.0	0.0	0.0	
Factor	$0.0	**PSC Cost Savings**	**0.0**	**0.0**	**0.0**	**0.0**	
1.60%	**Benefits Direct to MTF**	3rd Party Collect. (linked)	0.0	0.0	0.0	0.0	
		Other (Not Linked)	0.0	0.0	0.0	0.0	
		Other (Not Linked)	0.0	0.0	0.0	0.0	
	NPV	Other (Not Linked)	0.0	0.0	0.0	0.0	Inflow Total
	$0.0	**Direct MTF Savings**	**0.0**	**0.0**	**0.0**	**0.0**	**$0.0**
							36-Mo ROI
Net Savings or (Loss)			**0.0**	**0.0**	**0.0**	**0.0**	**$0.0**
Venture Capital Funding Requirement			**0.0**	**0.0**	**0.0**	**0.0**	**$0.0**

	Year 1	Year 2	Year 3	Year 4
Cumulative Investment	0.0	0.0	0.0	0.0
Cumulative Avoidance/Savings	0.0	0.0	0.0	0.0
Cumulative Net Savings or (Loss)	0.0	0.0	0.0	0.0

Data Source MEDCOM BCA webpage

Appendix C

Sample Pivot Table



Appendix D

	DEC 02	JAN 03	FEB 03	MAR 03	APR 03	MAY 03	JUN 03	JUL 03	AUG 03	SEP 03	OCT 03	NOV 03	AVG
BJACH	509	524	529	544	538	540	549	559	559	555	550	587	545
BAMC	2268	2280	2282	2311	2338	2356	2399	2437	2437	2423	2387	2469	2366
DACH	1255	1303	1320	1319	1312	1321	1340	1355	1370	1375	1359	1403	1336
EACH	1172	1158	1145	1159	1149	1157	1178	1197	1200	1205	1188	1234	1179
IACH	375	392	403	408	402	404	412	412	408	403	392	424	403
GLWACH	529	525	534	556	547	547	547	561	586	569	568	588	555
MAHC	301	302	298	307	307	312	311	318	324	317	314	314	310
RWBAHC	288	306	307	302	304	303	314	318	320	318	322	334	311
RACH	831	833	847	852	864	874	876	883	874	870	858	879	862
WBAMC	898	924	928	935	931	939	945	961	963	951	933	1002	943
GRAND TOTAL	8426	8547	8593	8693	8692	8753	8871	9001	9041	8986	8871	9234	8809

Note: Clinical Practice Guidelines (CPG) Metric Reporting through the Patient Administration Systems and Biostatistics Activity (PASBA)

Appendix E

M2 Data Results for Purchased and Direct Care

2002	PC		
	Visits	Sum Paid	Cost/Visit
BAMC	13	$356.00	$27.38
EACH	16	$736.00	$46.00
WBAMC	10	$501.00	$50.10
DACH	50	$2,760.00	$55.20
IACH	14	$654.00	$46.71
RACH	21	$914.00	$43.52
BJACH	36	$2,392.00	$66.44
GLWACH	10	$327.00	$32.70
RWBAHC	17	$784.00	$46.12
MACH	20	$1,250.00	$62.50
Total	207	$10,674.00	$51.57

2002	DC		
	Visits	Sum Paid	Cost/Visit
BAMC	59	$8,189.00	$138.80
EACH	1	$114.00	$114.00
WBAMC	5	$2,197.00	$439.40
DACH	3	$401.00	$133.67
IACH	1	$168.00	$168.00
RACH	354	$39,725.00	$112.22
BJACH	0	$0.00	$0.00
GLWACH	6	$679.00	$113.17
RWBAHC	1	$131.00	$131.00
MACH	3	$899.00	$299.67
Total	433	$52,503.00	$121.25

2003	PC		
	Visits	Sum Paid	Cost/Visit
BAMC	21	$1,030.00	$49.05
EACH	15	$786.00	$52.40
WBAMC	16	$1,021.00	$63.81
DACH	53	$3,059.00	$57.72
IACH	24	$1,142.00	$47.58
RACH	43	$1,715.00	$39.88
BJACH	26	$1,563.00	$60.12
GLWACH	21	$749.00	$35.67
RWBAHC	14	$669.00	$47.79
MACH	25	$1,399.00	$55.96
Total	258	$13,133.00	$50.90

2003	DC		
	Visits	Sum Paid	Cost/Visit
BAMC	342	$89,630.00	$262.08
EACH	26	$3,321.00	$127.73
WBAMC	18	$3,302.00	$183.44
DACH	2	$276.00	$138.00
IACH	1	$168.00	$168.00
RACH	13	$1,584.00	$121.85
BJACH	0	$0.00	$0.00
GLWACH	18	$2,197.00	$122.06
RWBAHC	1	$131.00	$131.00
MACH	3	$899.00	$299.67
Total	424	$101,508.00	$239.41

TOTAL FY 02 & 03			
	Visits	Sum Paid	Cost/Visit
BAMC	34	$1,386.00	$40.76
EACH	31	$1,522.00	$49.10
WBAMC	26	$1,522.00	$58.54
DACH	103	$5,819.00	$56.50
IACH	38	$1,796.00	$47.26
RACH	64	$2,629.00	$41.08
BJACH	62	$3,955.00	$63.79
GLWACH	31	$1,076.00	$34.71
RWBAHC	31	$1,453.00	$46.87
MACH	45	$2,649.00	$58.87
TOTAL	465	$23,807.00	$51.20

TOTAL FY 02 & 03			
	Visits	Sum Paid	Cost/Visit
BAMC	60	$97,819.00	$1,630.32
EACH	27	$3,435.00	$127.22
WBAMC	23	$5,499.00	$239.09
DACH	5	$677.00	$135.40
IACH	2	$336.00	$168.00
RACH	367	$41,309.00	$112.56
BJACH	0	$0.00	$0.00
GLWACH	24	$2,876.00	$119.83
RWBAHC	2	$262.00	$131.00
MACH	6	$1,798.00	$299.67
TOTAL	516	$154,011.00	$298.47

Data Source M2

Appendix F

GPRMC teleophthalmology BCA Quad Sheet

Net Savings & Loss Calculations ($000)

	Net Present Value (NPV)	Fiscal Year	Year 1	Year 2	Year 3	Year 4	36-Month Program Total
		# of Months	4	12	12	8	<--- = 36 Months
Savings to Investment Ratio (SIR)		Personnel (Linked)	254.7	304.2	304.2	49.5	
value < 1		Travel (Linked)	0.0	0.0	0.0	0.0	
is a		Leases/Rents (Linked)	0.0	0.0	0.0	0.0	
Negative		Contracts (Linked)	0.0	0.0	0.0	0.0	
ROI		Marg. Supplies (Linked)	5.0	6.5	8.3	10.7	
		Equipment (Linked)	88.0	88.0	88.0	0.0	
		Facility Mod (Linked)	0.0	0.0	0.0	0.0	
		Misc. (Linked)	0.0	0.0	0.0	0.0	
	NPV	Other (Not Linked)	0.0	0.0	0.0	0.0	Outflow Total
0.31	$1,185.6	**Requirement**	**347.8**	**398.7**	**400.5**	**60.2**	$1,207.2
	Benefits Cost Avoidance	MSCS (Not Linked)	0.0	0.0	0.0	0.0	
		Rev Financing (linked)	0.0	0.0	18.3	19.4	
		CHAMPUS A&O (linked)	0.0	53.2	76.2	99.1	
		TFL > 65 (linked)	0.0	0.0	0.0	0.0	
		Supp Care (linked)	0.0	0.0	28.1	29.8	
	NPV	Other (Not Linked)	0.0	0.0	0.0	0.0	
	$312.5	**Cost Avoidance**	**0.0**	**53.2**	**122.6**	**148.3**	
	Benefits PSC Savings	MCSC (Not Linked)	0.0	0.0	0.0	0.0	
		Rev Financing (linked)	0.0	17.2	0.0	0.0	
		CHAMPUS A&O (linked)	33.5	0.0	0.0	0.0	
		TFL > 65 (linked)	0.0	0.0	0.0	0.0	
		Supp Care (linked)	0.3	0.3	0.0	0.0	
Discount Factor	NPV	Other (Not Linked)	0.0	0.0	0.0	0.0	
1.60%	$51.1	**PSC Cost Savings**	**33.8**	**17.6**	**0.0**	**0.0**	
	Benefits Direct to MTF	3rd Party Collect. (linked)	2.1	2.2	2.4	2.5	
		Other (Not Linked)	0.0	0.0	0.0	0.0	
		Other (Not Linked)	0.0	0.0	0.0	0.0	
	NPV	Other (Not Linked)	0.0	0.0	0.0	0.0	Inflow Total
	$9.0	**Direct MTF Savings**	**2.1**	**2.2**	**2.4**	**2.5**	$384.7
							36-Mo ROI
	Net Savings or (Loss)		(311.9)	(325.7)	(275.6)	90.6	($822.5)
Venture Capital Funding Requirement			345.7	396.4	398.2	57.7	$1,197.9

Source: MEDCOM BCA template webpage

Appendix G

GPRMC Pivot Tables using M2 data

GPRMC Direct care pivot table

Proc1 Title	(All)
OHI	(All)
MTF	(All)
O/U 65	64 & under
P/NP/Tplus	PRIME

		FY		
BenCom Title	Data	2002	2003	Grand Total
AD	Sum of Encrs	31	70	101
	Sum of Var$raw	$3,547	$9,668	$13,215
ADD	Sum of Encrs	126	134	260
	Sum of Var$raw	$21,333	$24,311	$45,644
OTH	Sum of Encrs	617	662	1279
	Sum of Var$raw	$107,971	$146,452	$254,423
RET	Sum of Encrs	482	435	917
	Sum of Var$raw	$93,134	$96,124	$189,257
Total Sum of Encrs		1256	1301	2557
Total Sum of Var$raw		$225,985	$276,555	$502,540

GPRMC Purchased care pivot table

OHI RAW	(All)	
BPA MTF	(All)	
CPT	(All)	
PrimDiag T	(All)	Outpntnt only
P/NP/TFL	Prime	
SvcType T	Outpatient - excluding M, P, or N	
POS Title	(All)	
O/U 65	64 & under	

		FY		
BenCon	Data	2002	2003	Grand Total
AD	Sum of VisitsRAW	1	3	4
	Sum of Paidraw	$73	$182	$255
ADD	Sum of VisitsRAW	16	28	44
	Sum of Paidraw	$1,003	$1,800	$2,803
OTH	Sum of VisitsRAW	117	145	262
	Sum of Paidraw	$5,728	$7,209	$12,937
RET	Sum of VisitsRAW	73	82	155
	Sum of Paidraw	$3,870	$3,942	$7,812
Total Sum of VisitsRAW		207	258	465
Total Sum of Paidraw		$10,674	$13,133	$23,807

References

American Diabetes Association (1998). Diabetic Retinopathy. ***Diabetes Care, 21***(1), 157-159.

American Diabetes Association (n.d.). ***Eye care and retinopathy***. Retrieved September 22, 2003, from http://www.diabetes.org/info/complications/retinoathy/default.jsp

American Diabetes Association. (n.d.). ***Basic Diabetes Information***. Retrieved September 22, 2003, from http://www.diabetes.org/utils/print_this_page.jsp?PageID=BASICDIABETES_188446&S

American Diabetes Association. (n.d.). ***Diabetes and indirect costs of diabetes in the United States***. Retrieved September 22, 2003, from http://www.diabetes.org/info/facts/facts_costs.jsp

American Telemedicine Association, Ocular Telehealth Special Interest Group, & National Institute of Standards and Technology Working Group. (2004). Telehealth practice recommendations for diabetic retinopathy. ***The American Telemedicine Association***.

Bauman, W. (2003). Use of digital photography in the ophthalmology clinic for screening for diabetic retinopathy. ***Unpublished raw data***.

Brown, G. C. (1999). Vision and quality of life. ***Transactions of the American Ophthalmological Society, 97,*** 473-511.

Brown, G. C., Brown, M. M., & Sharma, S. (2000). Quality and cost effectiveness in health care: A unique approach. ***The Journal of Ophthalmalmic nursing and technology, 19***(1), 26-30.

Brown, M. M., Brown, G. C., Sharma, S., Kistler, J., & Brown, H. (2001). Utility values associated with blindness in an adult population. ***British Journal of Ophthalmology, 85,*** 327-331.

Brown, M. M., Brown, G. C., Sharma, S., & Garrett, S. (1999). Evidence-based medicine, utilities, and quality of life. ***Current Opinion in Ophthalmology, 10***(3), 221-226.

Brown, M. M., Brown, G. C., Sharma, S., Landy, J., & Bakal, J. (2002). Quality of life with visual acuity loss from diabetic retinopathy and age-related macular degeneration. ***Archives of Ophthalmology, 120***(4), 481-484.

Burns, N., & Grove, S. (2001). ***The practice of nursing research: Conduct, critique, & utilization*** (4th ed., Rev.). New York: W. B. Saunders.

Busbee, B. G., Brown, M. M., Brown, G. C., & Sharma, S. (2002). Incremental cost-effectiveness of initial cataract surgery. ***Ophthalmology, 109,*** 606-613.

Clinical Studies. (99, October 23). ***Diabetic retinopathy vitrectomy study***. Retrieved August 25, 2003, from National Eye Institute Web Site: http://www.nei.nih.gov/neitrials/static/study56.htm

Darkins, A. W. (2001). Message from the Acting Chief Consultant: A report on a VHA consensus symposium on screening for diabetic retinopathy via teleophthalmology. *The Telemedicine News for THA Telemedicine, 1*(3), 6-7.

Executive Information and Decision Support. (2003, October 14 updated). *Welcome to EI/DS*. Retrieved October 14, 2003, from http://eidsportal.ha.osd.mil/index.cfm/FuseAction/Products.htm

Finkler, S. A., & Ward, D. M. (1999). *Essentials of cost accounting for health care organizations* (2nd ed., Rev.). Gaithersburg, MD: Aspen Publishers, Inc.

Flowers, C. W. (n.d.). *Ophthalmology*. Retrieved August 22, 2003, from Telehealth Web Site: http://www.telehealth.hrsa.gov/pubs/tech/optha.htm

Freeman, M., Hammitt, J. K., & De Civita, P. (n. d.). On quality adjusted life years (QALYs) and environmental/consumer valuation. *Essay, 1,* 1-9.

Frey, K. A., & Bratton, R. L. (2002). Role of telemedicine in the health care delivery system. *The Journal of the American Board of Family Practice, 15*(2), 170-171.

Gapenski, L. C. (2001). *Understanding Healthcare Financial Management* (3rd ed., Rev.). Chicago: Health Administration Press.

Garber, A. M. (1999). Advances in cost-effectiveness analysis of health interventions. In J. P. Newhouse & A. J. Culyer (Eds.), ***National Bureau of Economic Research***. North Holland, Amsterdam.

Garthwaite, T. L. (1999, December 8). ***Guidance for credentialing and privileging telemedicine and telehealth***. Retrieved September 19, 2003, from http://www.va.gov/pub/direc/health/infolet/109918.html

Gomez-Ulla, F., Fernandez, M. I., Gonzalez, F., Rey, P., Rodriguez, M., Rodriguez-Cid, M. J., et al. (2002). Digital retinal images and teleophthalmology for detecting and grading diabetic retinopathy. ***Diabetes Care, 25***(8), 1384-1389.

Great Plains Regional Medical Command. (2003). Retrieved October 14, 2003, from Great Plains Regional Medical Command Web Site: http://gprmc.amedd.army.mil/shemel1_b.htm

Great Plains Regional Medical Command. (2004). ***Great Plains Regional Medical Command Balance Score Card*** [Brochure]. San Antonio: Author.

Griffith, S. P., Freeman, W. L., Shaw, C. J., Mitchell, W. H., Olden, C. R., Figgs, L. D., et al. (1993). Screening for diabetic retinopathy in a clinical setting: A comparison of direct ophthalmoscopy by primary care physicians with fundus photography. ***The Journal of Family Practice, 37***(1), 49-56.

Hodge, J. G., Gostin, L. O., & Jacobson, P. D. (1999). Legal issues concerning electronic health information: privacy, quality, and liability. *Journal of the American Medical Association, 282*(15), 1466-1471.

Houston, M. S., Myers, J. D., Levens, S. P., McEvoy, M. T., Smith, S. A., Khandheria, B. K., et al. (1999). Clinical consultations using store-and-forward telemedicine technology. *Mayo Clinic Proceedings, 74*(8), 764-769.

Jacobs, P., & Rapoport, J. (2002). *The Economics of health and medical care* (5th ed., Rev.). Gaithersburg, MD: Aspen Publishers, INC.

Javitt, J. C. (2000). How often should patients with diabetes be screened for retinopathy? *Journal of the American Medical Association, 284*(4), 437-439.

Javitt, J. C., & Aiello, L. P. (1996). Cost-effectiveness of detecting and treating diabetic retinopathy. *Annals of Internal Medicine, 124*(1S-II Supp), 164-169.

Javitt, J. C., Aiello, L. P., Chiang, Y., Ferris, F. L., Canner, J. K., & Greenfield, S. (1994). Preventive eye care in people with diabetes is cost-saving to the federal government. *Diabetes Care, 17*(8), 909-917.

Joslin Diabetes Center. (2003). Retrieved September 23, 2003, from http://www.joslin.harvard.edu/jnationwide/developing/jvn.shtml

Karagiannis, A., & Newland, H. (1996). Mobile retinal photography. A means of screening for diabetic retinopathy in Aboriginal communities. *Australian and New Zealand journal of ophthalmology, 24*(4), 333-337.

Laupacis, A., Feeny, D., Detsky, A. S., & Tugwell, P. X. (1992). How attractive does a new technology have to be to warrant adoption and utilization? Tentative guidelines for using clinical and economic evaluations. *Canadian Medical Journal of Medicine, 146,* 473-481.

Lee, P. (1999). Telemedicine: Opportunities and challenges for the remote care of diabetic retinopathy. *Archives of Ophthalmology, 117*(12), 1639-1640.

Lee, P., & Zhang, P. (2003). Economic analysis in eye disease. *Archives of Ophthalmology, 121*(1), 115-116.

Lee, S. C., Lee, E. T., Kingsley, R. M., Wang, Y., Russell, D., Klein, R., et al. (2001). Comparison of diagnosis of early retinal lesions of diabetic retinopathy between a computer system and human experts. *Archives of Ophthalmology, 119*(4), 509-515.

Li, H. (1999). Telemedicine and ophthalmology. *Survey of Ophthalmology, 44*(1), 61-72.

Liesenfeld, B., Kohner, E., Piehlmeier, W., Kluthe, S., Aldington, S., Porta, M., et al. (2000). A Telemedicine approach to the screening of diabetic retinopathy: digital fundus photography. *Diabetes Care, 23*(3), 345-348.

Maberly, D., Walker, H., Koushik, A., & Cruess, A. (2003). Screening for diabetic retinopathy in James Bay, Ontario: a cost-effectiveness analysis. ***Canadian Medical Association Journal, 168***(2), 160-164.

Mair, F., & Whitten, P. (2000). Systematic review of studies of patient satisfaction with telemedicine. ***British Medical Journal, 320***(7248), 1517-1520.

Massachusetts Medical Society (2000). Retinopathy and nephropathy in patients with Type 1 diabetes four years after a trial of intensive therapy. ***The New England Journal of Medicine, 342***(6), 381-389.

National Committee for Quality Assurance. (n.d.). ***Medicare HEDIS 2002 Audit Means, Percentiles, & Ratios***. Retrieved August 21, 2003, from http://www.ncqa.org/Programs/HEDIS/02medicare.htm

Office of Management and Budget. (2004). ***Discount rates for cost-effectiveness, lease purchase, and related analyses***. Retrieved March 25, 2004, from Executive Office of the President of the United States Web Site: http://www.whitehouse.gov/omb/circulars

Peters, A. L., Davidson, M. B., & Ziel, F. H. (1993). Cost-effective screening for diabetic retinopathy using a nonmydriatic retinal camera in a prepaid health-care setting. ***Diabetes Care, 16***(8), 1193-5.

Practice Management Information Corporation (2001). ***CPT-Plus*** (Millennium ed., Rev.). Los Angeles: American Medical Association.

Practice Management Information Corporation (2003). *International classification of diseases, 9th revision* (6th ed., Rev.). Los Angeles: American Medical Association.

Practice Management Information Corporation (2003). *International classification of diseases 9th revision* (6th ed.). Los Angeles: American Medical.

Random House (1997). feasibility. In *Random house Webster's College Dictionary* (2d ed., Rev.). New York: Random House.

Roine, R., Ohinmaa, A., & Hailey, D. (2001). Assessing telemedicine: a systematic review of the literature. *Canadian Medical Association, 165*(6), 765-771.

Russell, L. B., Gold, M. R., Siegel, J. E., Daniels, N., & Weinstein, M. C. (1996). The role of cost-effectiveness analysis in health and medicine. *The Journal of the American Medical Association, 276*(14), 1172-1177.

Scuffham, P. (2002). Systematic review of cost effectiveness in telemedicine: Quality of cost effective studies in systematic reviews is problematic. *British Medical Journal, 325*(7364), 598.

Shi, L., & Singh, D. (Eds.). (2001). *Delivering health care in America* (2nd ed., Rev.). Gaithersburg, MD: Aspen Publications.

Siegel, J. E., Weinstein, M. C., Russell, L. B., & Gold, M. R. (1996). Recommendations for reporting cost-effectiveness analyses. *The Journal of the American Medical Association, 276*(16), 1339-1341.

The American Academy of Ophthalmology (1993). ***Preferred Practice Pattern: Diabetic Retinopathy.*** San Francisco: AAO.

U.S. Army Military Health Services. (2004). ***Military Health Services***. Retrieved from http://www.tricare.osd.mil

Unknown. (n.d.). ***Canon Eye Q Series***. Retrieved August 22, 2003, from Canon Eye Q Series Web Site: http://www.lpoproducts.com/Products/LPO12.asp

Walker, J. F. (1997). Telehealth a complex issue being addressed by state and federal governments. ***AORN Online, 66***(4), 709-712.

Weinstein, M. C., Siegel, J. E., Gold, M. R., Kamlet, M. S., & Russell, L. B. (1996). Recommendations of the panel on cost-effectiveness in health and medicine. ***The Journal of the American Medical Association, 276***(15), 1253-1258.

Whitten, P. S., Mair, F. S., Haycox, A., May, C. R., Williams, T. L., & Hellmich, S. (2002). Systematic review of cost effectiveness studies of telemedicine interventions. ***British Medical Journal, 324***(7351), 1434-1437.

Wootton, R. (2001). Telemedicine. ***British Medical Journal, 323***(7312), 557-560.